

**Before the Subcommittee on Aviation,
Committee on Transportation and Infrastructure,
U.S. House of Representatives**

For Release on Delivery
Expected at
9:30 a.m. EST
Thursday
March 5, 1998
Report Number: AV-1998-089

Air Traffic Control Modernization

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Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to testify today on the Federal Aviation Administration's (FAA) air traffic control modernization efforts.

FAA has recognized the need to take control of its multibillion dollar air traffic control modernization program, which has experienced cost overruns and schedule delays. Administrator Garvey established a task force comprised of senior departmental officials as well as executives and experts from the aviation community to assess FAA's modernization needs. FAA reached out to the aviation community to solicit views and seek consensus on the priorities and objectives of the modernization program. As a result, the Committee should expect to see a more complete description of risks associated with acquisitions, realism in project schedules, clarity in the benefits to be derived by and costs to the user community, and greater focus on priorities.

Today we will be discussing four high priority FAA efforts identified by the task force as crucial to the success of FAA's modernization efforts. They are Year-2000 compliance, Standard Terminal Automation Replacement System (STARS), HOST replacement, and the Wide Area Augmentation System (WAAS).

- ☑ Year-2000 Compliance: (\$156 million for Fiscal Years 1997 through 2000) A top priority for FAA is to ensure that mission-critical computer systems properly process dates containing the Year 2000 and beyond. FAA has 430 mission-critical systems. As of February 26, 1998, FAA reported it completed assessments of all 430 systems and, of the 209 supporting air traffic services, 125 had been assessed as Year-2000 compliant. Completion of the assessment phase was 7 months beyond the target date set by the Office of Management and Budget.

FAA is now proceeding with a sense of urgency. FAA has to make the fixes, test the systems, and implement the solutions. FAA's target date for completing all of these actions is November 1999. In our opinion, FAA must accelerate the implementation date for Year-2000 fixes to June 1999 or sooner. Given FAA's track record for completing computer and software-intensive programs on schedule, we believe it would be wise to allow a cushion for schedule slippages and unexpected problems. The November 1999 target date is cutting it too close.

- ☑ STARS: (\$940 million in program costs) STARS will replace displays, software, and computers in terminal air traffic control facilities and is scheduled to become operational in Boston in December 1998. This date is likely to slip, but with strong management it need not slip by more than a few months. FAA is taking steps to resolve the STARS human factors issues. Since October, FAA has been working closely with users to identify human factors issues with the STARS controller and

maintenance workstations. The controller workstation evaluation identified 98 human factors issues and the two maintenance workstation evaluations identified 106 issues.

FAA has designed potential alternative solutions which are acceptable to the users for 87 of the 98 issues identified by air traffic controllers. For example, the initial STARS design used a format similar to Microsoft Windows™ to provide information to air traffic controllers in opaque windows that can be moved, resized, or closed as needed. Controllers expressed concern that the windows would obstruct safety-critical data. Several design alternatives have been prototyped which eliminate the need for windows, including a series of icons, function keys, and knobs. FAA and its contractor have also developed solutions for 47 of 106 issues on the maintenance and control workstation.

Once potential solutions acceptable to the users have been identified, FAA must then analyze the solutions for the impact on program cost and schedule. The toughest decision however, is determining when “enough is enough”. Given the variety of human skills and abilities, users will not consistently agree on the best way to solve a human factors issue nor on which issues have priority. Consequently, until processes or exit criteria are established to determine which solutions to implement - (weighing safety, user acceptance and cost) and when to implement them - (before deployment or after deployment during product improvement), FAA will have difficulty resolving STARS human factors issues. This could delay deployment of the system.

The STARS testing schedule has always been aggressive. In our opinion, the original schedule did not include time to correct deficiencies found during formal testing. FAA will have to do additional testing of the human factors solutions that was not previously planned. The combination of a 5-month software development delay, potential funding shortfall, and additional testing requirements, substantially increases the risk of not meeting the deployment schedule.

A lesson learned from the STARS program is that FAA must develop a process to integrate a structured, scientific human factors discipline throughout the acquisition process. In future acquisitions, FAA must avoid “11th hour” human factors evaluations when development is almost complete. Human factors evaluations must be performed early and throughout the entire acquisition process. The need for an effective human factors process will become more critical as FAA begins to field collaborative decision support systems needed for Free Flight¹. The design of these new systems to be used by controllers will, of necessity, require careful evaluation of human factors in order to be safe and effective.

¹ Free Flight is a concept of air traffic management that permits pilots and controllers to share information and work together to manage air traffic. With Free Flight, pilots will not have to fly routes structured around ground-based navigation systems.

- ☑ HOST Replacement: (\$190 million for Fiscal Years 1998 and 1999) The HOST replacement program will replace the mainframe computers at the enroute air traffic control centers. FAA has an urgent need to replace the HOST hardware because of a lack of certainty about Year-2000 compliance and supportability problems. FAA must review the thousands of lines of microcode (a machine language) to determine if the HOST is Year-2000 compliant. However, when this examination will be done is uncertain because FAA is having difficulty finding personnel with the necessary technical knowledge to perform the review and repair the microcode.

It is important to recognize that even if the HOST can be made Year-2000 compliant, the processor, the heart of the HOST computer system, has a September 30, 1998, end-of-service life. The processor uses Thermal Conduction Modules that contain processing chips. Module failures can have consequences because they cool the processing chips. There is a shortage of spare parts for five types of these modules and they are failing at an increasing rate. For these 5 modules, there were 4 failures in 1995 and 12 failures in 1997. In addition to age, one factor which may be contributing to the increasing failure rate is that refurbishing after 7 years, as recommended by IBM², was not done. Despite a worldwide search to acquire additional units, there are only six spares left in the inventory for a key module. When the spare modules are no longer available, FAA will have to obtain parts by cannibalizing HOST systems at its two support facilities.

Based on prior replacement efforts, FAA's ability to replace HOST hardware at its 20 enroute centers in less than 2 years is questionable. Therefore, FAA needs to proceed immediately to both replace the hardware and make the HOST Year-2000 compliant. FAA must identify its risks, prioritize and sequence its replacement plans, and secure adequate funding. Additionally, FAA must marshal the necessary resources and seek out the talent and tools needed to analyze and repair the HOST microcode for the Year-2000 problems. We believe a concerted effort by FAA, IBM, and Lockheed Martin will be needed to secure the necessary professional expertise.

- ☑ WAAS: (\$1.0 billion in program costs³) WAAS is a program to augment the Global Positioning System to provide navigation and approach capabilities for civilian aircraft. The initial WAAS system is scheduled to become operational in late 1999. The Secretary's February 1998 report on WAAS does a good job of describing the technical and program uncertainties in the WAAS program which must be resolved. These include uncertainties relating to interference from unintentional and intentional

² International Business Machines (IBM) was the HOST manufacturer. Lockheed Martin is the HOST support contractor.

³ The \$1.0 billion in Facilities and Equipment program costs for WAAS includes the prime contractor costs (including the failed Wilcox contract), development of standards and procedures, technical engineering and program support, the first year of communications satellites, and the services provided by the National Reconnaissance Office. The WAAS life-cycle cost estimate of \$3.0 billion through 2016 includes the total communications satellite costs estimated at \$1.3 billion.

jamming, ionospheric variation, number of communication satellites needed, and access to a second global positioning system civil frequency. Resolution of these uncertainties will impact not only the familiar issues of cost and schedule, but will also impact operational benefits of the system to both general aviation and commercial aircraft and the costs to users and their acceptance of the new technology. In light of these uncertainties, it is becoming clear that it would be prudent to assume a need for some type of back-up system for the foreseeable future. The type of back-up system selected will have a direct bearing not only on costs to the Government, but also on avionics costs to general and commercial aviation users.

FAA Must Resolve STARS Human Factors Issues

FAA's Standard Terminal Automation Replacement System (STARS) will replace controller and maintenance workstations with color displays, as well as computer software and processors at 172 terminal air traffic control facilities. The STARS acquisition program costs are approximately \$940 million and its estimated life-cycle costs are \$2.2 billion through 2025. STARS is scheduled to become operational at the first site, Boston, in December 1998. In our opinion, it is not likely that FAA will meet this schedule. There are three areas that present a risk to the STARS Program's cost and schedule. These areas are human factors, program funding, and system testing.

Human Factors: The largest risk area in the STARS Program is human factors. During our October 1997 testimony⁴, we discussed FAA's inadequate application of human factors during STARS development. As the system approached initial deployment, significant concerns were raised by the users. Since October, FAA has performed human factors evaluations on both the controller and maintenance workstations. These

evaluations were conducted with a wide representation of users and human factors experts. The controller workstation evaluation identified 98 human factors issues and the two maintenance workstation evaluations identified 106 issues.

However, identifying issues is only one part of the process. After the issues are identified, FAA must design potential alternative solutions and analyze them for cost and schedule impacts. Lastly, FAA must develop a methodology or exit criteria for deciding how to weigh cost and schedule alternatives to determine which solutions to implement, and when to implement them (i.e. before deployment, later during product improvement).

FAA has designed potential alternative solutions which are acceptable to the users for 87 of the 98 issues identified by air traffic controllers. For example, the initial STARS design used a format similar to Microsoft Windows™ to provide information to air traffic controllers in opaque windows that can be moved, resized, or closed as needed. Controllers expressed serious concern that the windows would obstruct safety-critical data and increase the time the controllers are not looking at the display. Several design alternatives have been prototyped which eliminate the need for windows and reduce “heads-down” time, including a series of icons, function keys, and knobs which would initiate commands previously accessed through the windows. In addition, the contractor has developed solutions for 47 of 106 issues on the maintenance and control workstation.

⁴ Observations on the Federal Aviation Administration’s Standard Terminal Automation Replacement System (STARS). Testimony before the Subcommittee on Transportation and Related Agencies, Committee on Appropriations, U.S. House of Representatives, on October 30, 1997.

Later this month, a team of maintenance technicians, human factors experts, and contractor staff plan to conduct prototyping to design potential solutions to the remaining open issues. Once potential solutions acceptable to the users have been identified, FAA must then determine the impact on program cost and schedule and make the tough decisions on when to implement the solutions.

Until exit criteria are established, FAA will have difficulty resolving STARS human factors issues and determining when “enough is enough.” Exit criteria are vital because, given the variety of human skills and adaptability, no one solution will fully satisfy all users. Not all users view the significance of a human factors issue in the same way nor do they consistently agree on the best way to resolve the issue. FAA and the users need to come to consensus on which issues to fix, how to fix them, and when to fix them so STARS can be deployed soon.

Program Funding: According to FAA, the STARS Program can be completed within its acquisition cost baseline. However, the program is experiencing a cash flow problem this year and FAA requested a Fiscal Year 1998 reprogramming of \$28.9 million. These funds will be used to sustain the increased software development and testing expenses, to accelerate deployment of equipment at selected sites, and to address the human factors issues. FAA estimates that failure to obtain the reprogramming will delay the schedule for approximately 1 year at all sites. In our opinion, this reprogramming request may not

be adequate because the costs to correct all controller and maintenance technician human factors issues have yet to be determined.

System Testing: As we reported previously, the STARS testing schedule has always been aggressive -- FAA compressed an estimated 32 months of development and testing into 25 months. In our opinion, the original schedule did not include time to rewrite code to correct the deficiencies identified during formal tests and to retest corrections. FAA will have to do additional testing of the human factors solutions that was not previously scheduled. The combination of a nearly 5-month software development delay, potential funding shortfall, and additional testing requirements substantially increases the risk of not meeting the scheduled deployment to Boston. Too frequently, when program development schedules have slipped, formal testing has suffered. In our opinion, a slip in the deployment schedule would be preferable to “short cutting” formal testing.

FAA Must Complete Efforts to Incorporate Human Factors in All Acquisitions

A lesson learned from the STARS program is the importance of applying a structured, scientific human factors discipline throughout the acquisition process. According to the National Research Council, “. . . good human factors is a ‘pay now or pay more later’ proposition. By the time the system reaches late stages of development or testing, major

design commitments have been made, resources have been spent, and there is reduced motivation to discover design flaws that threaten deployment schedules.”⁵

FAA has initiated action to better integrate human factors in its acquisitions. A Human Factors Process Group was established to develop a process to manage human factors and user involvement throughout all phases of acquisition programs. In January 1998, the Process Group issued a preliminary report describing a number of problems related to FAA’s management of human factors. The Process Group plans to release a final report in March 1998 which will include recommendations to address the human factors management problems they identified with FAA acquisition programs.

According to the preliminary report, FAA’s human factors management lacks a clearly articulated structure, human factors studies have not been given adequate resources, and results of evaluations have not been communicated to high-level decision makers. Our recent report on labor agreements in FAA⁶ underscores the group’s finding. We reported that only 12 percent of the estimated 516,000 official duty hours granted to National Air Traffic Controllers Association representatives in Fiscal Year 1996 was spent assisting FAA in developing and evaluating National Airspace System projects. User involvement is essential in evaluating human factors issues. In our opinion, a broader role for union

⁵ National Research Council, The Future of Air Traffic Control: Human Operators and Automation, Washington, D.C., National Academy Press, 1998.

⁶ Air Traffic Controller Workforce Labor Agreements, Report Number AV-1998-061, January 20, 1998.

representatives to assist in human factors efforts in support of modernization is warranted.

To illustrate the importance of implementing better human factors processes, FAA will need to apply this discipline when it updates equipment in the air traffic control towers. The current tower environment has large numbers of displays and keyboards, is crowded, and has limited space for controller access to critical data. For example, the Atlanta Hartsfield International Airport tower has 22 monitors and 22 data input devices for 9 systems at 6 controller positions. As new equipment has been added, air traffic control towers have not been viewed from a system perspective, but have evolved into a collection of independent subsystems. FAA should conduct human factors evaluations in the tower environment when adding new or replacement systems, thereby avoiding the proliferation of equipment and potential increased risk of operator error.

FAA also has the opportunity to use the new process for identifying human factors improvements in the Display System Replacement (DSR) Program. DSR is FAA's \$1.0 billion program to replace aging and unsupportable display equipment with new displays, hardware, and software in enroute traffic control centers. The first site, Seattle, is scheduled to be operational in October 1998. Controllers and maintenance technicians participated in the design and development of DSR. Suggestions from users resulted in a number of changes to the system. Since then, the controllers have expressed concerns that after the system is in use, more human factors issues may be identified. Prior to

making future enhancements to DSR, FAA should conduct a structured human factors evaluation of DSR to identify areas where human factors can be improved.

The need for human factors will become more critical as FAA begins to add collaborative decision-making systems needed for Free Flight. Under Free Flight, the controllers' role could significantly change from a decision-making and communications role to a collaborative and monitoring role. The design of systems that the controllers will use in this new role must be carefully evaluated for human factors in order for these systems to be safe and effective.

To assist the controllers in transitioning to Free Flight, FAA should reevaluate the focus of its research and development efforts in the area of human factors. Currently, FAA is involved in 241 human factors research projects. Of these, only 21 research projects, valued at approximately \$2 million, relate to human factors in modernization of the National Airspace System. Further, in its January 1998 preliminary report, the Human Factors Process Group also stated that the funding priorities for Research, Engineering and Development programs result in “. . . human factors research programs that do not complement or support the needs of acquisition programs. . . .” We believe that FAA should focus more of its human factors research and development resources on these new decision support systems that the controllers will be using in the future.

FAA Must Act Expeditiously to Ensure Year-2000 Compliance

With all the recent publicity, most industry observers know that many computer systems and software applications had been programmed with a two-digit year field. Computer systems and software applications programmed with a two-digit field will not be able to differentiate between the year 2000 and 1900, since both will have the same two digit representation of “00”. If the computer systems used by air traffic controllers are confused by an “00” year field, they could shut down or provide inaccurate information.

In our February 1998 testimony on Year-2000 issues⁷, we recommended that FAA (1) expeditiously appoint a person with strong technical leadership and authority to manage the Year-2000 program, (2) develop a master schedule for fixing and testing all mission-critical systems, (3) take prompt action to make necessary fixes to newly acquired but not yet operational systems, (4) promptly identify and secure resources needed to get the job done no later than June 1999, (5) report monthly to the Secretary and Congress on progress made toward fixing Year-2000 problems, (6) make a prompt decision on the HOST computer fixes, (7) develop a suitable contingency plan for the HOST computer, and (8) have an independent review of plans to fix and certify the existing HOST computer. The FAA Administrator acknowledged that FAA got a late start in addressing the Year-2000 issues and generally concurred with our recommendations.

⁷ The Year 2000 Presents Significant Challenges for the Air Traffic Control System, Report Number FE-1998-068, February 4, 1998

The Administrator has instituted a strong central management and a sense of urgency. However, FAA has not made a formal commitment to change the implementation date from November 1999 to June 1999. Attachment 1 includes target dates and cost estimates for resolving Year-2000 problems. Accelerating the target date for implementing all Year-2000 fixes is critical in case there are any schedule slippages or unexpected problems when installing Year-2000 fixes in the field. We are awaiting FAA's formal response to this recommendation.

The following chart shows the status of FAA's Year-2000 efforts as of February 26, 1998.⁸

Status of FAA's Year-2000 Efforts

Organization	Mission-Critical	Assessed	Approved by Quality Assurance	Year-2000 Compliant
Air Traffic Services	209	209	209	125
Administrative	122	122	N/A	0
Research & Acquisition	84	84	N/A	0
All Others	15	15	N/A	0
Totals	430	430	209	125

FAA Must Act Now to Begin Replacing HOST Hardware

The HOST computers at the enroute centers are part of the system that enables air traffic controllers to direct high-altitude air traffic. When the Advanced Automation System Program was restructured, FAA established a program to modernize and enhance the hardware and software for the HOST computer system and its backup system, Direct

Access Radar Channel (DARC), at its enroute centers by mid-2004. Today, FAA has an urgent need to replace the HOST hardware 4 years earlier because of the lack of certainty about Year-2000 compliance and, more importantly, supportability problems.

HOST Year-2000 Compliance

HOST Year-2000 problems could involve software and hardware. According to FAA, the enroute application software has been tested and successfully demonstrated the ability to survive the Year-2000 date change. However, the HOST microcode⁹ has potential Year-2000 problems. In an October 2, 1997, letter, IBM stated “Analysis of 3083¹⁰ microcode (a machine language) involves reviewing hundreds of thousands of lines of microcode written in several different protocols IBM does not have the skills employed today that understand the microcode implemented in the 3083 well enough to conduct an appropriate Year-2000 assessment. In addition, the tools required to properly analyze the microcode do not exist.”

FAA has done limited testing on the HOST computer microcode and, within 90 days after examining the microcode, plans to make a decision on whether the HOST can be repaired. However, when this examination can be done is uncertain because FAA is having difficulties finding personnel with the necessary technical knowledge. FAA is aggressively looking for the experts to review the microcode. Unfortunately, an expert

⁸ These statistics are as reported by FAA. We are currently reviewing the accuracy of this data.

⁹ Microcode is a very low-level code that defines how a processor operates. This code controls the computer's housekeeping functions internal to the HOST computer such as temperature controls.

previously identified by FAA, who participated in developing the original microcode, recently turned down FAA's offer to come on board. FAA must marshal the necessary resources and seek out the talent and tools needed to analyze and repair the HOST microcode for the Year-2000 problems. We believe a concerted effort by FAA, IBM, and Lockheed Martin will be needed to secure the necessary professional expertise.

Supportability

Even if the HOST can be made Year-2000 compliant, FAA's ability to continue to provide automated air traffic services at its enroute centers is jeopardized by serious supportability issues. FAA's HOST computer system (1970's IBM mainframe technology) was installed in the mid-1980's. According to Lockheed Martin, the HOST support contractor, eight key hardware units have an end-of-service life by December 31, 1999 (See Attachment 2). The main processor has a September 30, 1998, end-of-service life.

Furthermore, the processor is an IBM 3083 model BX which extensively uses Thermal Conduction Modules (modules). These modules contain processing chips. Module failures have operational consequences because they cool the processing chips. For example, on February 19, 1998, due to a module failure, the primary HOST system at the enroute center in Palmdale, California, could not operate for 6 ½ hours. During this time, the enroute center relied on its backup HOST processor. According to Lockheed Martin,

¹⁰ The HOST processor is an IBM model 3083.

IBM no longer has the ability to make repairs or refurbish the modules since IBM discontinued producing this processor model.

The following chart illustrates the severity of spare parts shortages for 5 of the 11 types of these modules in the 3083BX processor. The data show that the five modules are failing at an increasing rate. The total number of modules that failed in 1997 was three times the number that failed in 1995.¹¹ The most critical shortage is the module known as CLVM, shown in the chart below as type A. FAA uses 96 of these modules in processors around the country. Despite a worldwide search to acquire additional modules, there are only six spares left in IBM's inventory.

Five Thermal Conduction Module (TCM) Shortages and Failures

Type of TCM	Total Number In Use	Spares In Inventory as of 2/24/98	Number of Failures			Total Usage 1995-1997
			1995	1996	1997	
A	96	6	2	4	4	10
B	48	5	0	0	1	1
C	48	6	1	0	2	3
D	48	9	1	1	3	5
E	48	12	0	2	2	4
Totals	288	38	4	7	12	23

In addition to age, a possible contributing factor to the increasing failure rates of the modules is that a refurbishment after 7 years, as recommended by IBM, was not done. The modules have seals and a helium charge which can leak. No one knows how long

¹¹ According to IBM, there were no failures of these types of modules in 1998, as of February 24, 1998.

the remaining spares will support FAA's enroute operations. When the modules are no longer available, FAA will have to obtain parts by cannibalizing HOST systems at its two support facilities.

Significant Challenges Lie Ahead to Ensure Success

FAA plans to concurrently repair the HOST microcode to make it Year-2000 compliant and replace HOST hardware. For the HOST hardware replacement program, FAA estimates life-cycle costs to be about \$777 million¹² over 10 years.

We agree with FAA's decision to replace the HOST hardware concurrently with repairing microcode for Year-2000 compliance. However, FAA faces significant challenges and risks.

- ◆ Replacement of the HOST requires taking the software from the existing mainframe computer and installing it into the replacement hardware (called "rehosting"). The last time FAA rehosted these mainframe computers, the process took about 3 years. Rehosting in less than 2 years at all centers is extremely optimistic. In comparison, FAA's Display Channel Complex Rehost took almost 2 years to deploy to just five centers. It is unlikely that FAA can completely replace the HOST hardware at all 20 enroute centers in less than 2 years.

¹² This includes HOST and oceanic processors and peripherals at enroute centers. Peripherals include tape drives, disk drives, terminals, printers, and communications equipment.

- ◆ Another key concern is that both the replacement and repair efforts will demand the attention of the same FAA employees who are responsible for rolling out other new equipment. For example, at the enroute centers during this same period, work will be done on the HOST replacement and deployment of DSR.
- ◆ FAA's current contingency plan for the HOST computer is to use the DARC backup system. When the HOST computer cannot function, DARC displays aircraft location on the controller's screen. However, the aircraft flight identification information is not shown and controllers have to space aircraft further apart. DARC also does not have conflict alert which provides controllers with notice of an impending violation of separation standards between aircraft. Using DARC will slow air traffic. In addition, DARC is not yet Year-2000 compliant.
- ◆ The additional funding needed to begin replacing HOST hardware has not yet been secured. FAA's most recent estimate for replacing the hardware is about \$165 million in Facilities and Equipment costs, and \$25 million in Operations Funds in Fiscal Years 1998 and 1999. FAA has drafted a Fiscal Year 1998 reprogramming request for \$75 million to complete proof-of-concept and prototype testing, to procure computer processors, and to allow for initial software development.

While replacing the HOST hardware will eliminate both the Year-2000 and supportability problems, FAA's ability to accomplish this task at 20 enroute centers and 4 oceanic sites

in less than 2 years is questionable. Therefore, FAA must proceed to both replace the hardware and repair the microcode. Regarding the hardware replacement, FAA must identify its risks, prioritize and sequence its replacement plans, and secure the necessary resources. Additionally, FAA must obtain the talent and tools needed to complete the examination and repair of the microcode for Year-2000 problems. A joint government/industry commitment by FAA, IBM, and Lockheed Martin to find and provide these resources is needed now to identify the scope of the Year-2000 problem, determine what needs to be done, and solve this problem.

Uncertainties Relating to WAAS Must Be Resolved

WAAS will augment the Department of Defense's Global Positioning System to provide navigation and approach capabilities for civilian use in the National Airspace System. WAAS is a key technology needed for the implementation of Free Flight. The initial WAAS system is scheduled to become operational in late 1999. FAA expects to field full WAAS capability in late 2001. WAAS life-cycle costs have grown from \$1.4 billion in 1994 to an estimate of more than \$3.0 billion in 1998.

On February 11, 1998, the Secretary of Transportation reported to Congress on the WAAS program status and management. The report does a good job of disclosing technical and program uncertainties associated with the program. However, before FAA can achieve a full buy-in to the total WAAS project from stakeholders, uncertainties relating to interference from unintentional and intentional jamming, ionospheric

variations, number of communications satellites needed, and access to a second global positioning system civil frequency must be resolved.

Resolution of these uncertainties will impact the familiar issues of cost and schedule. For example, a determination has not been made on the second civil frequency needed for WAAS. The availability of a second signal is important because it can help mitigate interference and ionospheric issues. If aircraft are equipped with dual frequency receivers, ionospheric distortions to the signal could be calculated and corrected aboard the aircraft rather than by a ground station. A second coded civil frequency would also reduce the risk associated with unintentional interference. If the second civil frequency is the current “L2” signal, there will be an estimated one-time cost to FAA of about \$50 million to equip WAAS. If the frequency signal is different, then the costs to FAA could reach \$250 million.

Resolution of these uncertainties will also impact operational benefits of the system to both general aviation and commercial aircraft and the avionics costs to the users and their acceptance of the new technology. A back-up system for WAAS will be needed for the foreseeable future. It is unlikely that a back-up system can be eliminated until experience with the WAAS system shows that it is capable of providing almost flawless performance over a sustained period of time. The type of back-up system selected will have a direct bearing not only on costs to the Government, but also on avionics costs to general and commercial aviation users.

Mr. Chairman, this concludes our statement. I would be pleased to answer any questions.

Year-2000 Target Dates and Cost Estimates

YEAR-2000 PHASES AND TASKS	OMB TARGET	DOT TARGET	FAA TARGET	FAA COST
Assessment--Determine the Scope of Year-2000 Problems	6/97	8/97	1/98	\$9M
Renovation--Fix Year-2000 Problems	9/98	9/98	12/98	\$90M
Validation--Test the Fix	1/99	1/99	7/99	(Included Below)
Implementation--Implement Year-2000 Compliant Systems	3/99	3/99	11/99	\$57M
Totals				\$156M

HOST Hardware Units With End-of-Service Lives Prior to Year 2000

Type of Unit	Number in Use	End-of-Service Date
Keyboard Video Display Terminal	793	06/30/98
Modem	51	06/30/98
Processor Controller	48	09/30/98
Processor (IBM Model 3083BX)	48	09/30/98
Coolant Distribution Unit	48	09/30/98
Display Console	48	12/31/98
Communication Controller	26	12/31/99
Console	26	12/31/99